Measurements of Aerosol Physio-chemistry and Optical Properties aboard the DC-8 in support of the NASA (INTEX-A) Mission

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We propose integrate a variety of our instruments designed to characterize aerosol physio-chemistry and aerosol optical properties onto the NASA DC-8 in support of the NASA INTEX-A mission. This effort is proposed in close collaboration Dr. Bruce Anderson (NASA-LaRC) and his group in order to jointly obtain a complementary suite of aerosol data. Our combined instrumentation measures ambient in-situ aerosol microphysical properties in conjunction with on-board real-time assessments of their underlying physio-chemical characteristics. This will provide size-resolved data linking aerosol atmospheric effects to the nature of aerosol emissions and their composition.

Measurements will include:
1) A set of 3 condensation nuclei counters to determine total aerosol number density, the number of particles between 0.003 and 0.01 μm (ultrafine CN) and the factional volatility of aerosols > 0.01 μm (LaRC-UH).
2) A thermal tandem differential mobility analyzer (TDMA) and optical particle counter (OPC) to obtain total and nonvolatile aerosol size distribution over 0.010 to 7 μm (UH).
3) An aerodynamic particle sizer (APS) for mass-dependent sizing of 0.5 to 10 um diameter particles (LaRC).
4) A pair of wing-tip mounted aerosol scattering spectrometer probes to measure, in addition to cloud liquid water content, particle size distributions at ambient humidity over the 0.3 to 1550.0 μm size-diameter range(LaRC).
5) A pair of 3-wavelength, integrating nephelometers to measure total and submicron aerosol scattering coefficients (LaRC-UH).
6) Two Particle Soot Absorption Photometers (PSAPs) to record total and submicron aerosol (i.e., black carbon) absorption coefficients (LaRC-UH).
(7) Measurements of extinction vs. humidity [f(RH)] that quantifies the role of water uptake on the ambient scattering properties (UH), as detected by remote sensing.
Sample air will be provided to the cabin-mounted instruments via the UH shrouded inlet probe evaluated during the DC-8 Inlet Characterization Experiment (DICE) and found to efficiently transmit particles < 4 μm dry diameter.

As done on prior TRACE and ACE-Asia missions, UH will utilize size-resolved thermal volatility of the aerosol in conjunction with measured light scattering and light absorption to characterize the aerosol black carbon (BC) and volatile components including their state of mixing (Clarke et al., 2004). The relation of this absorbing BC to measured CO emissions will be investigated for various sources. Previous comparisons also reveal that our measured aerosol volatility is closely related to soluble species (as determined by the DC-8, PILS data; R. Weber) allowing us to estimate size resolved refractory and soluble compositions that can be linked to aerosol growth in response to humidity, f(RH). We will validate these assessments with our measured f(RH) allowing us to characterize the role of aerosol chemistry in establishing the ambient aerosol radiances and aerosol optical depths (AOD) seen by satellite (eg. MODIS, SeaWiFS). This will not only provide improved interpretation of satellite derived AOD in terms of various chemical components of the aerosol from North America but also facilitate linking satellite data products with chemical transport models (CTM). We will use our DC-8 data and work with Dr. G. Carmichael's CTM model group that is operational during INTEX to develop such relationships and also to help refine CTM optical parameterizations.

The state of mixing of BC with volatiles has also been found to influence the size-dependent nature of cloud condensation nuclei, CCN. We will use our measurements to evaluating the potential of satellite retrievals to assess ambient CCN via our inferred size-resolved CCN_{proxy}. Our work in TRACE-P showed that in Asian aerosol the CCN_{proxy} population was determined largely by the combustion derived BC population upon which most soluble species (eg. sulfate) was condensed. We will examine to what extent the aerosol from North America is similar. In conjunction with the measured humidity dependence of extinction, f(RH), these observations are fundamental to understanding the direct and indirect radiative effects of the aerosol including those properties responsible for the remotely sensed radiances observed.

The proposed collaboration and combined instruments provide a strong instrument package capable of addressing a variety of key issues related to size-resolved aerosol concentration, composition, transport, evolution, optical properties, radiative forcing and lidar or satellite remote sensing. Prior successful intercompariosion of these aircraft aerosol measurements with aircraft platforms in TRACE, ACE-Asia and DICE ensure that the results can be reliably integrated with other ITCT platforms. In order to link or observations to satellite derived radiances we expect to establish column integrated chemical and optical properties during vertical profiles. A number of these will be carried out in conjunction with other platforms such as the Ron Brown and J31 aircraft that have similar and/or complementary measurements. These platform intercomparisons will allow us to establish "closure" between DC-8 measurements and column properties (eg. spectral aerosol optical depth). Successful closure profiles will then allow reliable interpretation of our DC-8 profile data throughout the extended INTEX-A study region. We hope to coordinate these profiles with satellite overpasses whenever possible.

Clarke, A. D., V. N. Kapustin, Y. Shinozuka, S. Howell, B. Huebert, S. Masonis, T. Anderson, D. Covert, R. Weber, J. Anderson, H. Zin, K.G. Moore II, C. McNaughton; Size-Distributions and Mixtures of Black Carbon and Dust Aerosol in Asian Outflow: Physio-chemistry, Optical Properties, *Jour. Geophys, Res.,* in-press April. 2004.